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ABSTRACT

This report was developed as an outcome of a conference held in April 1983 by the Council for Basic Education. It concentrated on existing and proposed solutions to the shortages of qualified mathematics and science teachers and on technological concerns. It includes suggestions proposed by participants as well as additional recommendations made by educators and others interested in improving basic education who were consulted after the conference. This compendium of approaches is intended to be used as a resource directory by school administrators and other educators. The first section provides an overview of the extent of the problem. The next section is a compilation of proposed solutions for improving the quality of teaching and is followed by examples of specific programs. In the third section, issues and potential models are described. A summary and a directory of resources are included. (MNS)

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Math and Science:

Where Are the Teachers?

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A resource guide for citizens, educators, school boards, and policymakers

By Mary M. Conway

A report sponsored by

The Council for Basic Education

National advocates of the Liberal Arts for all elementary and secondary students.

MATH AND SCIENCE: WHERE ARE THE TEACHERS?

Shortcomings in the Teaching of Mathematics, Physical Science, and Technology in U.S. Elementary and Secondary Schools

by

Mary M. Conway

THE COUNCIL FOR BASIC EDUCATION
725 Fifteenth Street, N.W.
Washington, DC 20005

September, 1983

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With special thanks to my colleague, Dennis Houlihan,

whose ideas and research are incorporated into this report.

M.C.

Introduction

Many conferences and reports recently have examined conditions in the teaching of mathematics, science, and technology in elementary and secondary schools, and some of them have made valuable contributions in defining serious problems. On April 15, 1983, the Council for Basic Education held a conference called "Math and Science: Where Are the Teachers?" which had a very specific focus. The one-day CBE conference concentrated on existing and proposed solutions to the critical shortages of qualified teachers. This reflects the Council's view that good teachers are essential to any plan to alleviate the shortcomings of students' education in mathematics, physical science, and technology.

A few words about this report, its scope, its definition of terms, and its organization. First, the scope. The report grows out of the CBE conference. It includes suggestions proposed by the participants as well as additional recommendations made by educators and others interested in improving basic education who were consulted after the conference. This compendium of approaches is intended to be used as a resource directory for school administrators and other educators.

Second, the terminology. We chose to use the phrase "mathematics, physical science, and technology," hoping to clarify some common misconceptions. Although the expression "math and science crisis" is widely used, it is misleading on at least two counts. First, the science shortage is mainly in the physical sciences, that is, physics, chemistry, and the earth sciences. Biology teachers are

not in short supply, except in isolated situations. Second, by including technology in our list of trouble spots, we want to make it clear that we consider technology, or the study of applied science, a subject that is a necessary component of the basic education curriculum.

Using technological innovations, for example, the computer, as teacher aids is another quite separate issue which we will also discuss in the report.

Finally, a few words about the organization of this report. The section called "The Problem" provides an overview of the extent of the predicament. The next section, "Proposed Solutions," is a compilation of suggestions for improving the quality of teaching and is followed by examples of specific programs that were culled from the recommendations of educators and representatives of organizations concerned with mathematics, physical science, and technology as well as from a review of the literature and education press. The list is selective. A number of worthwhile projects that focus on other aspects of the educational process -- programs for improving the curriculum and student motivation, for example -- are not included because they are beyond the scope of this look at teacher-oriented solutions.

The next section of the report is called "The Issues and Potential Models." The issues discussed here summarize the panel sessions of the conference. The potential models that follow describe particular programs chosen for closer examination whether or not they were discussed at the conference.

The "Summary" section parallels the summary and remarks of the keynote speakers at the conference. The "Directory" section concentrates on sources of particular usefulness to educators wanting to know more about a particular solution proposed in the report. References to reports, conferences, and papers that simply define the scope of the problem, on the other hand, are generally confined to the text of the report. The "Directory of Additional Resources" lists organizations and projects that might be most helpful to the educator wishing to pursue particular proposals described in the report.

The Problem

"For every complex problem, there is a solution which is simple, direct, and wrong." --H. L. Mencken

The constituents of the unsatisfactory teaching of mathematics, physical science, and technology in elementary and secondary schools are interlocking. They include inadequate curriculum, shortages of quality teachers, and lowered levels of student involvement and achievement.

The National Commission on Excellence in Education reported that "in effect, we have a cafeteria-style curriculum in which the appetizers and desserts can be easily mistaken for the main courses."[1] It is generally agreed that not enough mathematics, physical science, and technology are included on the basic menu of our elementary and secondary school students. Yet, despite the agreement that exists among educators, parents, business leaders, and others advocating more academic study for all students,[2] no national consensus exists on what the curriculum for mathematics, physical science, and technology should be.

Since 1970 the trend nationwide has been towards reducing high school requirements. Only one-third of the 16,000 U.S. school districts require more than one year of mathematics or science for graduation, and only one-third of the nation's high school graduates have completed three years of math. Despite new and encouraging signs of change, nearly half of the student population takes no science after the tenth grade, and the amount of science being taught in elementary schools has declined since 1975. As far as technology is concerned, as Dr. Cecily Selby, Cochairman of the National Science Board's Commission on Pre-College Education in Mathematics, Science, and Technology, told a Congressional hearing, "There are few, if any, courses devoted exclusively to technology at the precollege

level. By technology, I mean the applications of science to society and . . . applied science itself."[3]

Most secondary school science instruction takes place in junior high school. This level has the teachers with the least adequate content preparation, poorest facilities, and fewest certification programs available.

A number of observers believe that the inadequacies which are glaring in secondary schools are deeply rooted in the elementary level of education. So far, however, much less attention has been given to the early years of education in these areas.

The education achievement of most elementary school teachers remains at a constant level, which is low. Fifty-one percent reported that they received no undergraduate training in science. A newer handicap: many schools that previously had science consultants no longer do because of budget cuts.

In addition, science teachers often have to work with grossly inadequate equipment. A National Science Teachers Association survey found that 60 percent of science teachers have experienced cuts in their budgets for supplies and equipment. These cuts have occurred at a time when school labs are already obsolete and when parents are demanding computers for their schools.

The immediate outlook for adequate numbers of high-quality future teachers is not bright. High school seniors specifically bound for teacher education programs scored, on the average, 48 points below the national average in mathematics skills on the Scholastic Aptitude Test.

Right now, 26 percent of all mathematics positions are filled by teachers who are not certified or licensed or who have only temporary credentials to teach mathematics. Among the newly employed secondary mathematics and science teachers, 50 percent do not have credentials in the teaching of science or mathematics. These ratios are often much worse in urban and rural schools.

A survey of 600 colleges and universities with teacher-training programs revealed a 64 percent decline from 1971 to 1980 in the number of secondary school science teachers being prepared and a 78 percent drop for mathematics teachers.

In addition, many certified math and science teachers today lack the contemporary training needed to teach an updated curriculum in mathematics, physical science, and technology.

Poor teaching quality is difficult to quantify, but the teacher shortage itself has been increasing since 1973. Dr. Trevor Howe and Dr. Jack Gerlovich, science education consultant to the Iowa State Department of Education, found that 45 states reported shortages of physics teachers and 44 had math teacher shortages. These findings were presented as results of a survey in a paper which Dr. Gerlovich coauthored with his colleague, Dr. Trevor Howe, entitled "National Study of the Estimated Supply and Demand of Science and Mathematics Teachers."

The number of science and mathematics teachers being prepared decreased by over 50 percent between 1970 and 1980. What's more, those already in the profession are leaving. Over four times as many science and mathematics teachers left for other employment as retired. Retirement itself may aggravate the shortage by 1985-1990 because the average age of science and mathematics teachers today is 41. As noted above, the mathematics and physical science teacher shortages are not uniformly distributed across state or school district boundaries. Urban and rural districts have long had difficulty attracting quality teachers.

The decline in student motivation is a contributing factor in the decrease in math and science courses taken and in the general performance of students. Students tend to abandon science and mathematics as soon as course requirements permit.

Proposed Solutions

Outmoded curricula, teacher shortages, and unmotivated students produce a vicious circle. The group that can most immediately and most effectively alter the current situation is the teachers. And so, improving the quality of teaching and increasing the quantity of teachers is the focus in this report.

For improving the quality of teaching we will explore in-service training and the supplemental use of loaned expert personnel. For increasing the quantity of mathematics, physical science, and technology teachers, three strategies will be explored: enhancing teaching as a profession, exploring new sources for teachers, and augmenting teacher productivity.

Some school districts and states are increasing salaries to enhance teaching as a profession and encourage teachers to stay. Awards for excellence are also being given to teachers. Students are being enticed into teaching through special loans and grants. New educational programs are being designed specifically to attract nontraditional candidates, including the retraining of teachers from other disciplines.

In an attempt to extend the reach of the teachers we have, the use of a variety of new technologies has been proposed, along with a longer school year and day. This last proposal is linked to salary increases for teachers.

What follows is by no means an encyclopedic list but rather a sampling of what is being done.

IMPROVING THE QUALITY OF TEACHING

In-Service Training

A National Science Teachers Association (NSTA) survey of science teachers found that 79 percent of those surveyed had not completed at least a ten-hour course or workshop in over ten years. Forty percent of them had not attended a course or workshop since they began teaching, which was, on average, 16 years before. Another NSTA national survey found that 71 percent of the school districts had no in-service training for science.

The extensive programs of the National Science Foundation that blossomed in the 1960s for the retraining of teachers were slashed in subsequent budget cuts. Today a shortage of summer institutes and college programs for qualified mathematics and physical science teachers exists.

Dr. Robert W. Howe, director of the Educational Research and Information Clearinghouse (ERIC) for Science, Mathematics, and Environmental Education, summarized his findings that "in-service education for teachers regarding alternative materials and different instructional techniques are needed. The former National Science Foundation/Coop Program was a good model. Research analyses indicate these programs did make a difference in teaching behavior and in the instructional program. These programs are needed at both the elementary and secondary levels." Examples of successful programs include:

* Wesleyan University in Middletown, Connecticut, is conducting a summer institute for grades 4-8 mathematics teachers. Dr. Robert A. Rosenbaum, university professor of mathematics and the sciences and director of the Wesleyan Mathematics Clinic, is one of the founders of the four-year-old Project to Increase Mastery of Mathematics (PIMM), which is funding the balance of the $27,000 summer institute. The participants pay what Dr. Rosenbaum described as "the bargain-basement amount of $100 for room and board." The program, which was funded for two summers by the National Science Foundation before monies were cut, consists of courses on math as well as workshops on math anxiety and avoidance. PIMM is a statewide organization of Connecticut industry, business, labor, state government, and education representatives working for the improvement of mathematics understanding and competence; the funding comes from United Technologies, Connecticut General, and General Electric, among others.

* Temple University in Philadelphia offers a Secondary School Mathematics Certification Program which is characterized by extensive mathematics preparation. The program, which usually lasts three years, consists of eight courses or 27 hours of course work, with tuition paid by the student.

President Ronald Reagan has spoken in favor of mathematics teacher training programs similar to that offered by Temple, with one major difference: he recommends a one-year teaching program, and Temple's Dr. Stephen Krulik insists that, "You cannot turn out a math teacher in less than two and a half years, and that's the absolute minimum." Dr. Krulik characterized the President's proposal as "a good Band Aid."

Temple is about to inaugurate a similar program in the sciences called the "Junior High School Science Certificate Program," which is also an eight-course program consisting of 27 hours of course work.

Temple is one member of a consortium of seven private colleges and universities in the Philadelphia area that agreed to work collaboratively with the Philadelphia School District on a Secondary School Mathematics Certification Program. Dr. Richard Polis, dean of the Graduate School at Beaver College in Glenside, Pennsylvania, has been director of the consortium, called University In-service Teacher Education Network (UITEN) since 1981. The private schools agreed to reduce their tuition for this program to the state level, which amounts to a one-third reduction of tuition. The program was initiated to alleviate a mathematics teacher shortage in Philadelphia.

* EQUALS Teacher Education Program is an in-service educators training program at the Lawrence Hall of Science at the Univeristy of California, Berkeley. It has served 1,500 elementary and secondary California educators and 2,000 others in 25 states. The focus of the program is attracting and retaining girls' interest in mathematics. It trains teachers to become trainers of teachers themselves. It is a program of the Math/Science Network at the Math/Science Resource Center at Mills College in Oakland, California.

* The Exploratorium in San Francisco trains teachers to make use of the exhibits by familiarizing them with the range of phenomena exhibited and with the relationships between the various exhibits. The museum offers a series of two-week workshops as well.

The Exploratorium's programs are among a number of nontraditional sources of teacher training offered by several museums around the country.

* For a program in Iowa, see pages 21-23 and page 38.

Loaned Expert Personnel

Working scientists, accompanied by an accredited teacher, can add a valuable adjunct classroom resource and serve to inspire students. A number of corporations are sharing their personnel with local schools in this and other ways. Examples:

* A program conceived in 1968 by the Rochester, New York, Section of the American Chemical Society and the Rochester Council of Scientific Societies, and sponsored since 1971 solely by the Xerox Corporation, brings scientists and engineers into city elementary classrooms on a biweekly basis to give demonstrations and provide direct experience in physics and mathematics. Working with local teachers, Xerox has developed a series of 40 kits -- complete with lesson plans, equipment, and materials -- to reduce the consultants' class preparation time. Xerox funds a program coordinator to work with employee volunteers and the local school system.

* The Atlantic Richfield Company (ARCO) in Los Angeles funded by the Joint Educational Project (JEP), a community development program which involves 100 company employees volunteering on release time in four inner-city schools. Some of them teach mathematics.

* Honeywell sponsors a program in Minneapolis (see pp. 28-30).

ENHANCING TEACHING AS A PROFESSION

Salary Increases

Stating that "the average salary after 12 years of teaching is only $17,000 per year," the National Commission on Excellence in Education recommended that "salaries for the teaching profession should be increased and should be professionally competitive, market-sensitive, and performance-based. Salary, promotion, tenure, and retention decisions should be tied to an effective evaluation system that includes peer review so that superior teachers can be rewarded, average ones encouraged, and poor ones either improved or terminated."

The National Task Force on Education for Economic Growth released its report this summer; it concurs that teacher salaries must be raised. The National Task Force, which is composed of 41 governors and leaders in industry, labor, education, and the scientific community, described the meager teacher salary levels as symbolic of the "low value that our society places upon elementary and secondary school teaching." The Task Force called upon the states to increase teacher salaries and also to look for ways to provide "extraordinary rewards for extraordinary teachers."

The American Federation of Teachers (AFT) endorses "comprehensive strategies to recruit new teachers . . . including extra pay for extra time if negotiated and voluntarily agreed to by the individuals involved. In the development of flexible arrangements, this might involve an extended school day for students. . . . In some situations where relative trust exists, the union condones teacher unions choosing to negotiate extra pay for extra time agreements."[4] Some examples of more flexible union-school district agreements follow:

* The United Federation of Teachers (UFT) recently agreed to a New York City Board of Education proposal to allow teachers in critical shortage areas to teach during "preparation periods" for extra money. The agreement will go into effect in September 1983. Speech improvement teachers will be the first to take advantage of the plan. So far no mathematics or science teachers are scheduled to

teach during the extra period. The teachers are paid an additional $4,500 annually for teaching the extra 45-minute period.

* In Simsbury, Connecticut, the school district and the local affiliate of the National Education Association (NEA) agreed to collapse the salary scale by eliminating the first four steps. They hope to attract beginning teachers with this move. (See page 26.)

* The Miami-Dade (Florida) School District negotiated with the United Teachers of Dade, an AFT affiliate, to allow incentive pay for shortage areas. (See page 26-27.)

The Southern Regional Education Board has found that a number of school districts in states that do not have collective bargaining rights for teachers are offering differential pay:

* A task force of the Georgia Board of Regents and the State Board of Education has recommended that Georgia break away from traditional salary schedules and differentiate pay for priority locations, disciplines, and teaching performance.

* A liaison committee of the Virginia Council of Higher Education and the Virginia Board of Education recommended that the state provide funds to enable school boards to offer supplements to attract mathematics and science teachers. Governor Charles Robb has announced a proposal for merit pay.

* The Maryland Commission for Quality Education has proposed differential pay as well as an 11-month contract.

* Newly certified mathematics and science teachers are being given a $2,000 bonus to teach in the Richmond, Virginia, schools. Two years' commitment is required or the money must be repaid.

* The North Carolina School Board is seeking $3.9 million to offer one-third of the state's science and mathematics teachers extended contracts.

* A school district in the Dallas metropolitan area is paying two teachers with doctorate degrees extra money to work on special projects in addition to teaching. The Dallas Independent School District has a proposal to pay teachers an extra $5,000 to work an extended contract. Certified mathematics and science teachers are two of the subject areas chosen for eligibility in the program.[5]

Awards for Excellence in Teaching

* The National Science Foundation gives awards for excellence. The 1983 budget includes $1 million for Presidential awards for secondary mathematics and science teachers.

* The National Science Teachers Association, in conjunction with the Council of State Science Supervisors, conducted a "Search for Excellence." A total of 165 nominees were chosen with the help of 50 state educators, most often the state science consultant. The winners included 12 in elementary science, technology, and society.

* The Connecticut Business and Industry Association is planning to start a master fellowship program for high school teachers in 1984. As now envisioned, the fellowship would be awarded to 30 teachers a year. In addition to a stipend, each of the mathematics and science teachers would be offered summer employment and speaking engagements.

* The Dreyfus Institute on High School Chemistry at Princeton University selected 50 chemistry high school teachers to become "Dreyfus Master Teachers." After four weeks of intensive training in teaching methods, which included the role of the microcomputer, the master teachers

returned to their own schools to conduct regional meetings to share their materials and ideas. This new summer institute was inaugurated in 1982.

* The CIBA-GEIGY Corporation sponsors a national exemplary science teaching award for a secondary, a middle-junior high, and an elementary school teacher.

* Ohaus Scale Corporation gives cash awards to science teachers at the secondary level for unusual innovation in science teaching.

EXPLORING NEW SOURCES FOR TEACHERS

Loans and Grants

Using loans and grants at the state level to increase the number of mathematics and physical science teachers is a concept that is gaining momentum. In addition, pending federal proposals include provisions for loans. It is not a new idea. In fact, state-level use of service payback or loan forgiveness to attract teachers predates the 1958 National Defense Education Act (NDEA). Unfortunately, these state programs were not evaluated. However, evaluations have been made of similar federal programs.

Mr. Jim Stedman, an education specialist at the Congressional Research Service, completed a review in January 1983, called "The Experience with Loan Forgiveness and Service Payback in Federal and State Student Aid Programs."

Mr. Stedman found that "the simple addition of a forgiveness provision to an existing loan program will not provide the leverage on the recipients needed" if the intention is to address a labor shortage. "The buy-out terms under which a recipient can avoid providing service and the amount of the aid received are the major factors influencing the repayment decision of a recipient."

Using student loans to ameliorate elementary and secondary school teacher shortages was heralded a quarter century ago. The NDEA gave loans to college students and allowed them to cancel up to half their debt by teaching in public elementary and secondary schools. The concept behind this program went unchallenged for a decade. In 1968 a College Entrance Examination Board study for the U.S. Office of Education recommended repealing the student loan forgiveness provisions, saying that "the study staff has been unable to find any clear-cut evidence that the teacher cancellation provision has materially contributed to an increase in either the number or quality of teachers."[6]

Dr. Katherine K. Merseth, special assistant to the dean for institutional planning at the Harvard Graduate School of Education, has pointed out another factor to be considered in the current move to repeat the corrective steps of 25 years ago. "A simple review of the census statistics," she commented, "indicates that the number of 19- to 25-year-olds, those forming the traditional labor pool of beginning teachers, will decline by 25 percent in the next 12 years. This causes me to believe that the bills pending in Congress to forgive undergraduate student loans for the study of scientific education will be much less effective than the 1958 NDEA measure."

The Southern Regional Education Board has found that several states have created loan programs in response to their mathematics and physical science teacher shortages:

* Money or programs to retrain teachers who are certified in areas other than mathematics or science are being initiated at both the state and local levels. In Florida, for example, appropriations provide for up to ten semester hours, tuition free, for math and science teachers wanting to upgrade their skills and for retraining out-of-service teachers.

* Concerning fellowships, scholarships, and loans on the state level, Kentucky and Alabama are in the forefront. Kentucky was the first state to enact legislation for this purpose. The appropriations for 1982-84, a two-year total of

$610,000, are earmarked to provide $2,500 per year for sophomores, juniors, and seniors in state colleges preparing to become science or mathematics teachers. Approximately $800 per summer session is provided for out-of-field teachers who attend courses in science and mathematics. The loans are to be repaid at the rate of one year of teaching for every year of scholarship, with one semester of teaching for every summer session. In 1982-83, 99 scholarships or loans were awarded. The 1983 Georgia General Assembly followed suit by appropriating $135,000 to the State Student Finance Commission for a math/science scholarship loan program.

* North Carolina's existing state scholarship is giving priority to students who plan to teach mathematics and science. Awards of $1,500 are given.[7]

New Teacher Sources

Although no one is certain how deep the pool of interested talent may be, qualified candidates from nonteaching professions are one possible source of new teachers, provided they can be given the help they need to adapt to the classroom.

* Dr. Katherine Merseth spoke at the CBE conference about the Harvard Graduate School of Education (HGSE) Midcareer Math and Science Program which will train experienced scientists, mathematicians, and engineers as teachers. Ten retirees and midcareer applicants who already have expertise in mathematics will attend the first eight-course, 32-credit, one-year program, which will begin in the fall of 1983. Later the program will be expanded to 25 students, including those with expertise in science. The applicants are being drawn from nearby high technology and other companies.

Extensive fieldwork in actual teaching situations will account for nearly half of the program. Harvard plans a wide variety of teaching experiences for these prospective secondary mathematics teachers, including two weeks each in an urban school, in a suburban school, with a large class, and as a tutor. Harvard hopes to attract corporate scholarships for the $8,320 tuition. The cost of running the program for the first three years is $150,000; after that, Harvard hopes that it will be self-sustaining.

Early Recruitment

Another idea for finding new teachers depends on the early identification of promising high school students and college freshmen and sophomores who show a strong interest in teaching.

* "Grow Your Own," a program of the Houston Independent School District, is a senior high school program for aspiring teachers. The program encourages bilingual teenagers to become teachers by paying them as half-day teacher aids and by paying for two years of their college education. Anticipating future needs, one goal of the program is producing bilingual mathematics teachers.

Retraining From Other Disciplines

Perhaps the most likely source of teachers in fields now short of qualified staff is to be found in schools and disciplines with surplus teachers or teachers who are eager to move into new disciplines.

* "Project Search," another program of the Houston Independent School District, set out to find teachers in the district who could be reclassified through additional training as mathematics or science teachers in the middle/junior high schools and senior high school. "Project Search" advertisements aimed at the teachers in the district

offered incentives including payment of tuition for course work as well as the cost of books and other supplies, a $250 stipend upon successful completion of each three-hour course, and an assignment as a secondary mathematics or science teacher eligible for the $2,000 "Second-Mile Plan" stipend. (See pages 23-24.)

Sixty-five participants were admitted into the program after being approved by the Curriculum Screening Committee as well as the Administrator Screening Committee.

"Project Search" is built on these elements: the recent change in Houston from junior high to middle schools for grades 6-8; the willingness of elementary teachers to move to the middle school assignments; Texas certification rules, which permit a teacher with elementary certification and 18 content hours to teach in the middle schools; and, finally, the financial incentive of the "Second-Mile Plan."

AUGMENTING TEACHER PRODUCTIVITY

Educational Technology

Dr. Arthur S. Melmed, director of education, technology and science in the Office of Educational Research and Improvement of the U.S. Department of Education, wrote that "perhaps the central problem for education and educational research for the remainder of this decade is how to improve productivity in education. Failure to deal successfully with this issue must inevitably lead to continued reduction in the real income of teachers."

"The real question," according to Dr. Melmed, "is how can teachers handle large numbers of students and still get the same measure of student achievement as with a small class?"

We are not talking about technology replacing teachers, but rather augmenting their efforts and relating that to salary enhancement. Technology in education has mainly been viewed as enriching the

individual student; the dearth of research on improved teacher productivity through technology needs to be corrected.[8] An example of such an application of technology:

> The electric chalkboard enables a master teacher to conduct a class at a remote location in addition to his own. Support staff monitor the second classroom. The East Oak Cliff subdistrict of the Dallas Independent School District has used the Gemini 100 Electronic Blackboard in this way. The joint classes taught by the master teacher are followed by smaller, individual workshops conducted by teachers or teacher aids at each site.[9]

Longer Year, Longer Day

The National Commission on Excellence in Education has proposed lengthening the school day as well as the school year. The Commission's report noted that Britain and other industrial countries have school days of up to eight hours and school years of up to 220 days. In the United States the typical school day is six hours and the school year is 180 days.

The California Round Table, a group of business executives concerned with improved education, has also proposed lengthening both the school day and year as have other organizations.

The Issues and Potential Models

The CBE conference explored four areas of potential solutions to the mathematics, physical science, and technology teacher shortage in elementary and secondary schools. They are teacher training, financial incentives, business-education alliances, and technology in education.

A summary of each of the four topics discussed at the conference is followed by a description of a potential model for each.

TEACHER TRAINING

The Issue

Session I of the CBE conference was on "Teacher Training and Renewal: A Quick Fix or a Practical Solution?" Dr. Jack Gerlovich and Dr. James Wilson addressed the issue.

Dr. James Wilson, head of the Mathematics Education Department at the University of Georgia, spoke out against "the wholesale assignment of certified nonmathematics teachers or of noncertified teachers to mathematics classes." The "contempt" expressed in the "devaluation of mathematics teaching," Dr. Wilson argued, is as much a factor in driving teachers from the profession as is the low salary scale.

The requirements in the Mathematics Education Department at the University of Georgia, Dr. Wilson said, are equivalent to those for mathematics majors. "As we recruit young people to consider mathematics teaching as a career, we want to draw from the same talent pool as the fields of engineering, computer science, and mathematics. We cannot accept the demeaning notion that only the less talented are fit to teach."

Dr. Wilson stressed that "whatever is done to retain or retrain mathematics teachers, the long-term solution to the crisis in mathematics teaching is a far more serious problem than acceleration in the rate at which teachers are leaving."

Dr. Jack Gerlovich, the science education consultant to the Iowa State Department of Education, underscored the point by telling the conference that in 1982 Iowa's 27 colleges had produced only two individuals to teach physics. The school administrators' response to the shortage was provisionally to certify teachers; this in turn created further problems. "In many instances," Dr. Gerlovich said, "these provisionally certified teachers become permanently assigned to teaching the course without securing additional education. This then has a dire result: the quality of the instruction is poor and discourages talented students."

The Potential Model

Dr. Gerlovich has designed a pilot program for retraining biology teachers, who are in abundance in Iowa, as physics teachers, who are in short supply in the state. Dr. Gerlovich feels his program is successful, inexpensive, and easily replicated in other states and for other subjects. Preliminary reports seem to bear out his view.

The program consists of using an interactive telephone system to prepare physics teachers in rural Iowa to teach the subject matter in an informed, stimulating way. Each teacher has a phone hookup in the classroom. The teachers receive a call from a university physics specialist who acquaints them with the new materials in the teachers' guide, discusses the intent of the videotapes, reviews the math to be used in the class, and provides guidelines for use of the computer

simulation activities. Thirty minutes of the time is spent on content and 15 more on such activities as discussing how to set up the project. Ten minutes is allotted to teachers discussing the project among themselves.

The first step in setting up the program was determining the need. "We surveyed all of the physics teachers in the state. Sixty to 70 percent of them responded," Dr. Gerolovich said. He found that virtually all of them were biology teachers, and he set up the curriculum guide with their special needs in mind. The teachers' guide contains student application activities, teachers' notes on conducting the activities, and mathematical guides. "Know your audience" is Dr. Gerlovich's prime advice for those setting up similar programs.

The program at the moment consists of six pilot schools at cost to each school of $355 to $635. During 1983-84 the pilot schools will be increased to 45. By 1984-85 the remaining 400 Iowa school districts will be hooked into the system at a cost of approximately $200,000. The course will be offered three times a day. Dr. Gerlovich believes that eventually the program could be used not only for retraining teachers in other subjects but also for directly teaching students.

An evaluation of the program is due but was not completed in time for publication of this report. Dr. Gerlovich said that the program called for three "face-to-face" meetings with the participants in the course of the program. "At first the feedback was pretty negative. Mostly that was because we didn't have the videotape done and there were limitations on the hardware." The meetings provided valuable feedback. "By March, things were positive, and by April, the whole attitude was positive."

Ms. Peggy Steffen, a teacher in the Fremont High School, is one of the six teachers participating in the pilot project. She said, "One of the most useful aspects is getting teacher support from higher levels of learning to give us activity ideas. Basically the problem in small districts is that teachers have to teach a wide variety of science courses in some of which they have no training. I was a biology major. I have to teach chemistry and physics. Well, I didn't

go to college expecting to teach those subjects. The program is basically setting up a support system in which this information is passed on. The telelecture system is excellent."

Ms. Steffen's only criticism of the program is that "it would be more helpful if we had more than limited access to the computer. Right now we have one computer in the school for 200 people. The computer right now is the icing on the cake. The project stands on its own."

Ms. Steffen added, "Dr. Roy Unruh, the physics professor at the University of Northern Iowa, gave a lecture to the students on physics a week and a half ago. He'd sent down 16 35-millimeter slides. We have these Radio Shack boxes in the classroom and the phone hookup. Five schools were connected and the Department of Education and Dr. Unruh. The students liked it. It's somebody different." Even in the pilot stage, some of Dr. Gerlovich's latter-day dreams are taking shape.

FINANCIAL INCENTIVES

The Issue

Session II of the CBE conference was on "Financial Incentives: Feasible or Futile?" Ms. Mira Baptiste and Dr. Robert Williams addressed the issue.

Ms. Mira Baptiste, the executive director of the Houston Independent School District's Employee Development Department, is convinced that financial incentives are feasible. She spoke to the conference about Houston's drastic action to deal with its critical shortage of secondary mathematics teachers. "On any given day in 1978-79," Ms. Baptiste told the conference, "some 6,000 Houston students sat in mathematics classes without certified teachers before them." Defying long standing union opposition to merit pay, the Houston district instituted a program called "The Second-Mile Plan," which, among other things, offered a critical staff shortage stipend of $2,000 in 1982-83 for teaching assignments in secondary science,

mathematics, bilingual education, and special education. The number of vacancies in critical staff shortage areas decreased from 251 in August 1979 to 87 in August 1982.

Ms. Baptiste explained that the plan included other stipends that, added together, allowed a Houston teacher to enhance the basic salary by $5,000. In an interview following the conference, Ms. Baptiste said that additional stipends were paid for working at a shortage location, ($2,000); for outstanding merit ($800); for additional professional training ($300 for each six-hour course); and for unused sick days, which are sold back to the district ($100 [illegible]). She said that these stipends had allowed Houston to decrease teacher shortages and reduce absenteeism. The Second-Mile Plan has cost the district $17.9 million over the last three years. "Not many districts could allocate those resources," Ms. Baptiste conceded. In fact, she added, "next year Houston will not be able to maintain the stipend levels" of 1983.

Houston teachers are already highly paid. Houston has cut five steps out of its 15-step salary scale. Beginning teachers with no experience up to teachers with three years' experience are paid $16,000. Under the new 10-step plan, top scale for teachers will be $35,000 instead of $28,000.

Dr. Robert T. Williams, associate dean of the School of Education at North Carolina State University, also believes that financial incentives are a viable solution. "Mild problems can be solved with mild solutions, but severe problems will require drastic solutions. Houston is an example of a severe problem, and they decided on a severe solution."

Dr. Williams stressed that analyzing the problem closely is imperative if money is not to be thrown away and opportunities missed. Dr. Williams described seven stages in the career span of a mathematics or physical science teacher. "We have a shortage of mathematics and physical science teachers because of the cumulative effect of decisions that are made at each stage." An example of the kind of low cost suggestion that Dr. Williams made is that school districts hire new college graduates to go on the payroll June 1. "Don't give them

the opportunity to get onto a nonteaching payroll. There are plenty of teaching needs and nonteaching needs they could meet." He also suggested persuading county commissioners or legislators to give tax exemptions to teachers in fields of shortage.

"A multifaceted problem requires a multitude of solutions," said Dr. Williams. "Many small actions by high school counselors, teacher educators, school district personnel, and business and industry could have a cumulative effect to reduce the shortage."

The Potential Model

Using financial incentives to decrease critical teacher shortages is still a controversial subject. If last year it was inflammatory, this year the suggestion is merely volatile. The reason, of course, is that such schemes as the Houston plan are feasible only in states which do not have collective bargaining laws; and they are in a minority.

One harbinger of the change in thinking in this area is Mr. Albert Shanker, the president of the American Federation of Teachers. He recently told a teachers' union convention: "Our response should not be a knee jerk type of response. This is an absolutely new situation. These are some of the greatest opportunities in terms of improving schools and raising teachers' salaries."

Since the majority of schools are in states with collective bargaining laws, it makes sense to look at models that comply with these laws. Although the programs we will discuss are too new to have had an effect, much less to have been evaluated, they are nascent models. The first is in a small Northeastern district, the second in a large Southern one.

In Simsbury, Connecticut, the school district and the union agreed to collapse the salary scale by eliminating the first four steps. The district hopes to attract beginning mathematics and science teachers with this move.

Superintendent Ralph Sloan had lost 25 teachers of the 350 in the district to industry and business. So he called for a meeting with the town's Board of Finance and Board of Selectmen. They agreed to set as their goal for the year improving teachers' salaries.

Next, the district negotiated with the Simsbury Education Association, an affiliate of the National Education Association.

The district and the union agreed to increase the starting salary from $13,500 to $16,350 in 1983-84 by "collapsing" the first four steps in the pay scale. According to this plan, beginning teachers earn the same as teachers with five years' experience.

Neighboring towns have followed Simsbury's lead. Superintendent Sloan believes that one reason the plan works is that, proportionately, school districts have so few beginning teachers that the cost of raising entry-level salaries is minimal. Simsbury has only 12 teachers affected by the new salary scale.

Although it is too early to know if this change will produce the desired results, Superintendent Sloan feels that his district has taken an important step towards attracting new teachers.

The Miami-Dade (Florida) School District negotiated a contract in June 1982 with the United Teachers of Dade, an affiliate of the American Federation of Teachers. The contract allows new teachers in confirmed areas of critical shortage to begin teaching at the fourth step on the salary scale. When a critical shortage teacher is brought in on that plan, other teachers in the same critical shortage area are also raised three steps, so that a second-year teacher would move to step five.

The contract will not go into effect until September 1983. The Florida House of Representatives is considering upgrading the mathematics and science high school curricula, which would increase the need for teachers in those areas. If Florida passes "The Mathematics, Science and Computer Education Act of 1983," thereby creating the need for more teachers, the Miami-Dade School District contract may make it easier to fill the new positions.

BUSINESS-EDUCATION ALLIANCES

The Issue

Session III of the CBE Conference was on "Business and Education: Is Partnership Possible?" Mr. Robert Heltman and Ms. Sylvia Ware addressed the issue.

Mr. Robert F. Heltman, program manager of the Professional Recruiting and University Relations Operation for the General Electric Company, said, "I firmly believe that much can be done in retraining math and science teachers and other teachers in a broader understanding of how math and science is used and applied in the world of work, through local community programs that link educators and those in the world of work occupations and professions." Ms. Sylvia Ware, head of educational services for the American Chemical Society, shared her views on business-education alliances: "It should be quite evident that, even with the best of intentions, business-school partnerships are not substitutes for a coherent federal policy designed to promote and support science and math education for all our children in all our schools throughout the nation. However, for limited programs in specific and fortunate communities, business-school partnerships will make the difference between mediocrity and excellence in precollege science and mathematics education in the near future."

One education organization with 38 years of experience with business and industry, the National Science Teachers Association (NSTA), offered some observations on the most successful education-

business collaborations. Ms. Phyllis Marcuccio, the NSTA's project director for business-industry education, said in an interview, "First, the programs are best worked out individually and, second, except for awards or scholarships, industries want to work at the local level."

The Potential Model

Dr. J. Myron Atkin, dean of the Stanford University School of Education, pointed out in an interview that although considerable journalistic attention is given to business-education collaborations, he is not aware of any systematic evaluations which have been done of these programs. Partly this is because they are generally of short duration. Dr. Atkin predicted "increased attention to policy-oriented applications of science in the 1980s that you didn't see in the 1960s." He also foresaw "increased involvement with corporations, which is essentially constructive."

In the absence of evaluations, we have looked at one of the educational programs of a company which has a long record of involvement in education. In fact, 45 percent of this company's annual giving is for educational purposes.

The program we are examining is Summatech, a Minneapolis Public School and Honeywell Corporation partnership project. It is a magnet program in math, science, and technology for grades 9-12. Minneapolis is the headquarters for Honeywell, and the Minneapolis Public School District is no stranger to corporate collaborations. We are not looking at a new business-education relationship, although the specific project is too new to have been evaluated yet.

Summatech is located at North High School, in a minority community. The program presently has 120 math and science students enrolled in the 9th and 10th grades. Seven teachers, one counselor, one administrator, and one coordinator staff the program. The teachers each conduct three classes in Summatech and two other classes in the comprehensive system at North High.

Planning for Summatech began in May 1981. The first classes were offered in September 1982. Honeywell's cash contribution was $40,000. One-fourth of that amount was designated for project planning, implementation, and teacher development. The remaining $30,000 pays half the salary of the school project coordinator over a two-year period. The school district pays the other half.

According to Ms. Linda Lane, the program director, staffing costs are $90,000. She said that the costs of rehabilitating the physical plant and shifting equipment at North High School to accommodate Summatech have not been calculated.

Ms. Lane described the difficulties facing the program. They did not have to do with the business-education aspect of the project. "The biggest problem we've had this year is inappropriate planning. We're building the curriculum as we go along. It leaves the staff with an awful lot to do. All seven staff members are working on the curriculum. It's a tremendous demand on energy and time. At the same time, we're recruiting students for next year."

Summatech's planners hope that eventually the magnet school -- one of four at the North High School location -- will be a laboratory school for science educators. For now, Ms. Lane said, that goal is far away.

Honeywell has been indispensable in training the Summatech teachers. So far this year, two Summatech science teachers, two math teachers, the counselor, and the computer instructor have received training in computer use, partially funded by Honeywell. The training has taken place at Honeywell, at community colleges, and at the Minnesota Educational Computing Consortium. Honeywell also has paid for Summatech teachers to attend national conventions and visit similar math and science magnet schools in Fort Worth and Houston. Honeywell plans to expose math and science teachers to the latest science and technology developments through sabbatical workshops.

A Honeywell employee comes to Summatech once a week to work with a group of students on computer use. One Honeywell employee is working on developing programs. In total, 42 Honeywell volunteers, most of whom are scientists from the corporate technology center, contribute to the Summatech project.

From Honeywell's perspective, the important elements in the successful implementation of the program include a joint commitment to working together in the planning stage, availability of exemplary curriculum materials in the Minneapolis Public Schools, and accessibility in the district to the computers and computer programs needed to initiate computer instruction throughout the district.

TECHNOLOGY AND EDUCATION

The Issue

Session IV of the CBE conference was on "Computers in Schools: Asset or Liability?" Mr. Terry Gill and Dr. Andrew Molnar addressed the issue.

"In plain language, technology literacy has many of the attributes of what we have traditionally described as a good liberal arts education . . . . 'Technology literacy' in this frame of reference means the competence required to engage in complex thinking -- that is, the possession of the appropriate knowledge and skill to access a continuously changing base of information. . . . The focus must ultimately be on engaging critical thought and teaching people how to continue learning."[10]

Dr. Richard H. Hersch,
Dean of the Graduate
School,
University of Oregon

"Technology, in addition to being a subject for study, provides a marvelous tool for the educational process."

Dr. Cecily Selby,
Cochairman
National Science Board
Commission on Precollege
Education in Mathematics,
Science, and Technology

In exploring the issues involved in technology and education, the CBE conference first looked at the effect of computers on the mathematics, physical science, and technology teacher shortage. Then the discussion went on to look more broadly at technology education in elementary and secondary schools.

Addressing the conference, Mr. Terry A. Gill, chairman of the Mathematics Department at the Career Enrichment Center for the Albuquerque, New Mexico Public Schools, said, "The introduction of the computer into the math classroom has compounded the teacher shortage. In fact, there continues to be a number of math and science teachers who either refuse their teaching load and migrate into computer science departments to teach programming, or leave the classroom to become district computer coordinators or part of the support staff. And of course, there are those who after receiving further training leave the field of education completely to join the computer business or the vendor world."

"At the moment," Mr. Gill said, "the content teachers are using the computer mainly as a motivational device."

Although the computer is not relieving the teacher shortage at the present time, it does have that potential in the future. "When sophisticated software becomes available," Mr. Gill said, "one way to alleviate the teacher shortage and also use the computer is through stratification of staff. A master teacher and teacher aides will be able to facilitate learning in a combined computer lab and classroom situation. Releasing the teacher to serve more students by allowing time for the needed human interaction is the greatest (future) asset of the computer."

Dr. Andrew Molnar, program director in the Award Administration and Liaison Section, Office of Scientific and Engineering Personnel and Education in the National Science Foundation, also spoke about technology in education.

Dr. Molnar said, "Merely adding computers to the classroom without restructuring our educational system, revolutionizing our

curriculum, and retraining a whole generation of teachers is more likely to create computer anxiety than computer literacy and productive thinking and problem solving."

He added, "I think we must come to grips with the strategic problem and that no amount of incrementalism, new salaries, or new incentives is going to solve the problem. What we must do is create a new confidence in education, and I think that new confidence rests on this new educational imperative: the computer."

About 44 percent of the senior high schools and 11 percent of the elementary schools have microcomputers. Yet a recent survey conducted by the National Science Teachers Association found that 69 percent of the teachers surveyed had never attended a computer course or workshop.

The Office of Technology Assessment (OTA) recently issued a report called "Informational Technology and Its Impact on American Education," which found widespread agreement that, with few exceptions, the quality of educational software, that is, the curriculum material designed for educational technology, was generally not very good.

The OTA study also found that "information technologies can be most effectively applied to educational tasks when they are well integrated into their institutional environment." Yet even for drill, the primary use of the computer in education today, the computers are not well integrated into the educational system.

The study also found that "much remains to be learned about the educational and psychological effects of technological approaches to instruction. Not enough experience has been gained with the new information technology to determine completely how that technology can most benefit learners or to predict possible negative effects of its use."[11]

The Potential Model

The Teacher Education and Computer (TEC) Center Program in California is the model we have chosen to describe because of the scale of the undertaking and its apparent success. The 15 regional TEC centers, which were authorized by the 1982-83 California budget act, represent a statewide system providing teacher development. The centers' funding must be renewed in the 1983-84 budget.

The centers replace or incorporate public organizations, such as the Federal Teacher Centers and the Professional Development and Program Improvement Centers, which had been providing staff development for ten to 15 years. In addition to adding the component of computer training, the new system attempts to correct geographic inequities.

"The TEC centers are the driving force of staff development in our state," said Mr. Ron Temple, a consultant in the California Department of Education's Office of Program Evaluation, which is in the final stages of a descriptive evaluation of three of the 15 regions in the program. "There's been fantastic interest in the centers among teachers who have been a little bit jaded in the past. There is a real awareness level of computer technology. What the centers have decided on is training teacher trainers."

The budget act requires that 60 percent of the TEC centers' budget fund mathematics, science, and computer activities.

Dr. Emanuel J. Scrofani, director of the Office of Staff Development at the California Department of Education, described the beginning of the program. "The TEC centers started on a piece of butcher paper in our office here." Many of the TEC centers include several counties. Dr. Scrofani said that the first task was to travel to each of the counties to explain the program, ask them to form their own policy boards and establish their bylaws. This process was completed in six weeks, starting in June 1982. By September the centers opened.

In addition to establishing local-level governance, another difficulty to be overcome was the fact that the centers replaced earlier organizations "which had to be compressed into the regional centers." The previous organizations "saw themselves as autonomous. There was the fear of losing representation of a certain philosophy that they were operating with," according to Dr. Scrofani.

One key to the success of the program is good organizational structure. Another is keeping control of the program "in the hands of the regional directors. The county people have an awful lot of visibility," Dr. Scrofani said.

The budget act authorized $5.7 million for the development of the new centers, the transition of the former centers into the TEC centers, and the purchase of computer equipment. An additional $120,000 was earmarked for a particularly innovative aspect of the program, the Software Library and Clearinghouse.

Ms. Ann Lathrop is the coordinator of the clearinghouse, which is housed in the San Mateo County Office of Education. In addition to screening and evaluating software for the 15 TEC centers, the clearinghouse is a valuable resource for K-12 educators throughout the country.

The clearinghouse has produced "The 1983 Educational Software Preview Guide," in which titles are organized for K-12 software into specific subject areas, grade levels, and instructional modes. Seventeen educational computer organizations traveled to California last January to review and evaluate the programs that are previewed in the guide.

Another service offered by the center is Softswap, a collection of public-domain and individually contributed computer programs that teachers can swap or purchase. The programs have been field-tested and evaluated. These services are available to educators throughout the country, not only to the 15 TEC centers.

Summary

Teacher training and in-service upgrading emerged as the most important priorities in the conference participants' deliberations on solutions to teacher shortages in mathematics, physical science, and technology.

Dr. Katherine Merseth named two premises on which to base solutions, namely, "individual teachers do make a difference" and "teachers in order to be effective must be masters of what they teach."

Congressman Dave McCurdy of Oklahoma, who also addressed the CBE conference, underscored these ideas as well. He pointed to proposed legislation that he sponsored addressing the mathematics, physical science, and technology teacher shortage, "H.R. 1310 recognizes that the key to a quality education is a quality teacher."

Recognizing the importance of federal initiative in providing leadership, Representative McCurdy also told his listeners, "We're crisis managers in the Congress. I'm afraid that this is the case unless you have a significant constituency. We're a cyclical body. I don't find many people other than a handful of us who are adequately concerned about the [teacher] issue on a long-term basis to follow through. In order to get that majority, there has to be pressure." He urged those interested in education to exert that pressure.

Dr. F. James Rutherford, chief education officer of the American Association for the Advancement of Science, concurred. "In spite of all of the talk about the serious shortage of science and mathematics teachers (which is real), the first issue is that of quality. Nothing

has been solved by filling up classrooms with unprepared or otherwise mediocre teachers."

Dr. Rutherford also stressed that "any effort to modernize schools technologically must include plans for producing computer materials for training the teachers."

He warned that our national response to the problem has not been comprehensive, lacked a unifying strategy, and failed to address the issue of capitalizing the reform. Dr. Rutherford added, "It is not a matter of 'doing the right thing,' but rather of doing all the right things."

Ms. Virginia Robinson, editor and manager of Education Times, in summing up the conference discussed the ancillary issues of business and education, financial incentives, and computers in the schools in the context of quality teaching. She stressed the importance of perceiving "the computer as a way to take care of some of the things that educators always say they would do if they had time. If the computer adds to what education does, it'll be wonderful. If it is used to substitute, it'll be back in the closet with the audiovisual equipment."

Then Ms. Robinson asked a broader question about the focus of our attention on the teacher shortage "crisis": "Is it the teachers or is it our inability to come to terms with a technology that is creating the mathematics and science crisis for us in the first place?"

In that context, she said, the national questioning of the nature of education in mathematics, physical science, and technology has significance beyond the immediate. The current focus on this issue she said, is "the symbolism of the change in our lives. We're not really talking about mathematics and science and technology. [We are talking about] learning and the capacity to learn and whether we in education are creating people who not only can learn but are fired to learn. [We are talking about] the whole nature of how human beings expand their capacity to know."

Footnotes

1. "An Open Letter to the American People, A Nation at Risk: The Imperative for Education Reform."
The Final Report of the National Commission on Excellence in Education, Washington, D.C., 1983.

2. "An AFT Interim Report on Math and Science Education and the Math and Science Teacher Shortage."
American Federation of Teachers, Washington, D.C., 1983.

3. Hearings on Mathematics and Science Education, U.S. House of Representatives Committee on Labor and Education, Joint Hearings, Subcommittee on Elementary, Secondary, and Vocational Education and Subcommittee on Postsecondary Education, September 28-30, 1982.

4. "AFT Interim Report."

5. Dr. Lynn M. Cornett, "The Crisis in Science Education: A Southern Regional Perspective."
Address given at the National Science Teachers Association National Meeting, Dallas, April 1983.

6. Mr. Jim Stedman, "The Experience of Loan Forgiveness and Service Payback in Federal and State Student Aid Programs."
Congressional Research Service, Washington, D.C., January 27, 1983.

7. "Scholarship -- Loans for Math/Science: A Part of the Solution." Southern Regional Education Board, Atlanta, March 1983.

8. Dr. Arthur S. Melmed, "Productivity and Technology in Education." Paper prepared for Educational Leadership, Journal of the Association for Supervision and Curriculum Development, November 1983.

9. Ms. Yvonne Ewell, "Use Technology to Cope with the Scarcity of Math and Science Teachers." American School Board Journal, Vol. 164, No. 9, September 1982, pp. 26.

10. Dr. Richard H. Hersch, "On Roads, Bridges and Schools: The Infrastructure Necessary for Technological Literacy." Paper, November 1982.

11. "Informational Technology and Its Impact on American Education." U.S. Congress Office of Technology Assessment, Washington, D.C., November 1982.

TEACHER TRAINING

In-Service Teacher Training

*The Iowa Model

"A Tool for Assessing and Revising the Science Curriculum." Iowa Department of Public Instruction, Revised Edition, Des Moines, Iowa, September 1981.

"Applying Technology to Alleviate the Problems Created by the Shortage of 'Qualified' Mathematics and Science Teachers." Dr. Jack A. Gerlovich, Address given at Council for Basic Education's conference on "Math and Science: Where are the Teachers?" Washington, D.C., April 15, 1983.

CONTACT: Dr. Jack A. Gerlovich, Consultant, Science Education, Department of Public Instruction, Grimes State Office Building, Des Moines, Iowa 50319

SEE: this report, pages 21-23.

Summer Award Institute

*The Dreyfus Institute on High School Chemistry

"The Dreyfus Institute on High School Chemistry: A Retrospective." Paper prepared by Dreyfus Institute, Princeton, New Jersey, October 4, 1982.

The Woodrow Wilson National Fellowship Foundation, with support from the Camille and Henry Dreyfus Foundation, works with science educators to identify the best faculty and participants for the summer institute.

CONTACT: The Dreyfus Institute on High School Chemistry, The Woodrow Wilson National Fellowship Foundation, Princeton, New Jersey 08540

SEE: this report, pages 13-14.

Teacher Training at Institutions of Higher Learning

*The Midcareer Math and Science Program

CONTACT: Dr. Katherine K. Merseth, Special Assistant to the Dean for Institutional Planning, Harvard University Graduate School of Education, Longfellow Hall, Appian Way, Cambridge, Massachusetts 02138

SEE: this report, page 15.

*The Interactive Technology and Education (ITE) Program

This new program, beginning in the fall of 1983, aims to create educators who are knowledgeable yet critical users of technological tools such as the computer. The one-year graduate program offers two graduate degrees, a Master of Education (Ed.M.) and a Certificate of Advanced Study (C.A.S.).

CONTACT: Dr. Jerome T. Murphy, Associate Dean, Harvard University Graduate School of Education, (address above)

*The Philadelphia Plan

The Secondary School Mathematics Certification Program

CONTACT: Dr. Stephen Krulik, Mathematics Education, Temple University, Philadelphia, Pennsylvania 19122

SEE: this report, pages 8-9.

*The University In-Service Teacher Education Network (UITEN)

CONTACT: Dr. A. Richard Polis, Mathematics Department, Beaver College, Glenside, Pennsylvania 19038

SEE: this report, page 9.

*The Wesleyan Program

CONTACT: Dr. Robert A. Rosenbaum, Department of Mathematics, Wesleyan University, Middletown, Connecticut 06457

SEE: this report, page 7.

Math and Science Teacher Projects

*The EQUALS Mathematics Project

"The EQUALS Mathematics Project Final Report: 1981-1982." Nancy Kreinberg, Berkeley, California, 1982. This document is particularly useful because it includes detailed evaluations by the teacher participants.

"Use EQUALS to Promote the Participation of Women in Mathematics," Alice Kaseberg, Nancy Kreinberg, Diane Downie. Math/Science Network, Lawrence Hall of Science, University of California, Berkeley, 1982.

"Math For Girls and Other Problem Solvers," Diane Downie, Twila Slesnick, Jean Kerr Stenmark. Math/Science Network, Lawrence Hall of Science, University of California, Berkeley, 1981. Curriculum to increase the participation of 6-to 14-year-old girls in after school mathematics courses.

CONTACT: Dr. Nancy Kreinberg, Director, EQUALS, Lawrence Hall of Science, University of California, Berkeley, California 94720

SEE: this report, page 9.

*The Math/Science Resource Center

The Resource Center disseminates 1,000 packets of literature designed for specific audiences, including precollege educators. The center, which has a membership of 1,000, has been instrumental in establishing and encouraging spin-off networks in Los Angeles, Albuquerque, Salt Lake City, and St. Louis.

CONTACT: Dr. Jan MacDonald, Coordinator, Math/Science Resource Center, Mills College, Oakland, California 94613

SEE: this report, page 9.

FINANCIAL INCENTIVES

*"Two Successful Financial Incentive Programs: Houston Independent School District." Address (see also accompanying tables) at Council for Basic Education's conference on "Math and Science: Where are the Teachers?" Washington, DC, April 15, 1983.

*"Financial Incentives to Combat the Shortage of Mathematics and Physical Science Teachers: Feasible or Futile." (Also addenda: "Solutions to Math/Science Teacher Shortage" and "Nine Opportunities for Local School Districts to Reduce Their Shortage of Mathematics and Physical Science Teachers.")

Dr. Robert T. Williams, Address given at Council for Basic Education's conference on "Math and Science: Where Are the Teachers?" Washington, DC, April 15, 1983.

SEE: this report, pages 24-25.

BUSINESS-EDUCATION ALLIANCES

Directories

A number of organizations have published or plan to publish directories of business-education collaborative efforts.

*"Let's Not Reinvent the Wheel," Institute for Educational Leadership, 1001 Connecticut Avenue, N.W., Washington, DC. It is a listing of local-level ventures.

*"Education/Industry: A Directory of Cooperative Initiatives," New England Congressional Institute, 53 D Street, S.E., Washington, DC 20003.

*The Education Commission of the States plans to publish the results of a 50-state survey of all business-education alliances state by state. It may be available by late summer 1983. Education Commission of the States, 444 N. Capitol Street, N.W., Washington, DC 20001.

*The California Round Table is planning a survey of business--education alliances in California, followed by a listing of model programs.

*The American Chemical Society has begun collecting information for a resource directory of model industry-education programs, which should be published before the end of 1983. American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036.

Organizations

Each state has its own organization serving as liaison between industry and education. One of the longest established is the Connecticut Business and Industry Association, 370 Asylum Street, Hartford, Connecticut 06103. Ms. Ann Wingate is its vice-president.

Programs

*Summatech

"A Partnership Model: The Minneapolis Public Schools/Honeywell Technology Team to Implement the Summatech Concept in the Minneapolis Public Schools." Honeywell paper, August 21, 1981.

SEE: this report, page 28-30.

*Marsha Levine, Denis P. Doyle, "Private Meets Public: An Examination of Contemporary Education." In Jack A. Meyer (ed.), Meeting Human Needs: Toward A New Public Philosophy. American Enterprise Institute for Public Policy Research, Washington, DC, 1982.

*PIMM

For the business-industry side of this collaboration with education, Mr. Thomas Furtado, who chaired the PIMM Development Committee, is an informative source.

CONTACT: Mr. Thomas Furtado, Manager, Communications Programs, Manufacturing Division, Pratt & Whitney Aircraft, United Technologies, 400 Main Street, East Hartford, Connecticut 06108

Publications

*"BIE Report," National Science Teachers Association, a newsletter for the business-industry education community. "BIE Briefs" is a section featuring BIE ventures around the country. A contact name and address are included with each entry.

CONTACT: Ms. Phyllis Marcuccio, "BIE Report," National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009

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Copies of the conference program and speeches given at the April 15, 1983 conference are available from the Council, at $4.00 per speech. Contact:

Council for Basic Education
725 Fifteenth Street, N.W.
Washington, D.C. 20005
(202) 347-4171

MATH AND SCIENCE: WHERE ARE THE TEACHERS?

Council for Basic Education Conference, April 15, 1983

Keynote Address
Math and Science Teacher Shortages: Dilemmas Old and New
Dr. Katherine Merseth
Special Assistant to the Dean
Graduate School of Education
Harvard University

Session I
Teacher Training and Renewal: A Quick Fix or a Practical Solution?
Dr. Jack Gerlovich
Science Education Consultant
Iowa State Department of Education

Dr. James Wilson
Dean
Mathematics Education Department
University of Georgia

Session II
Financial Incentives: Feasible or Futile?
Ms. Mira Baptiste
Executive Director
Employee Development Program
Houston Independent School District

Dr. Robert Williams
Associate Dean
School of Education
North Carolina State University

Luncheon Address
Science Education: The Way to Reform
Dr. James Rutherford
Chief Education Officer
American Association for the Advancement of Science

Keynote Address
A View from Congress: The Role of the Federal Government in Math and Science Education
Rep. Dave McCurdy
Member, House Comm. on Science and Technology
(D. - Oklahoma)

Session III
Business and Education: Is Partnership Possible?
Mr. Robert Heltman
Program Manager
Professional Recruiting and University Relations Operation
General Electric Company

Ms. Sylvia Ware
Director
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Session IV
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